



DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 25

[Docket No. FAA-2021-0894; Special Conditions No. 25-791-SC]

Special Conditions: Boeing Commercial Airplanes Model 777-9 Airplane; Operation without Normal Electrical Power

AGENCY: Federal Aviation Administration (FAA), Department of Transportation (DOT).

ACTION: Final special conditions; request for comments.

SUMMARY: These special conditions are issued for the Boeing Commercial Airplanes (Boeing) Model 777-9 series airplane. This airplane will have a novel or unusual design feature when compared to the state of technology envisioned in the airworthiness standards for transport category airplanes. This design feature is electrical and electronic systems that perform critical functions, the loss of which could be catastrophic to the airplane. The applicable airworthiness regulations do not contain adequate or appropriate safety standards for this design feature. These special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

DATES: This action is effective on Boeing on [INSERT DATE OF PUBLICATION IN THE FEDERAL REGISTER]. Send comments on or before [INSERT DATE 45 DAYS AFTER PUBLICATION IN THE FEDERAL REGISTER].

ADDRESSES: Send comments identified by Docket No. FAA-2021-0894 using any of the following methods:

- *Federal eRegulations Portal:* Go to <https://www.regulations.gov/> and follow the online instructions for sending your comments electronically.

- *Mail:* Send comments to Docket Operations, M-30, U.S. Department of Transportation (DOT), 1200 New Jersey Avenue, SE, Room W12-140, West Building Ground Floor, Washington, DC, 20590-0001.
- *Hand Delivery or Courier:* Take comments to Docket Operations in Room W12-140 of the West Building Ground Floor at 1200 New Jersey Avenue, SE, Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.
- *Fax:* Fax comments to Docket Operations at 202-493-2251.

Privacy: Except for Confidential Business Information (CBI) as described in the following paragraph, and other information as described in 14 CFR 11.35, the FAA will post all comments received without change to <https://www.regulations.gov/>, including any personal information you provide. The FAA will also post a report summarizing each substantive verbal contact received about these special conditions.

Confidential Business Information: Confidential Business Information (CBI) is commercial or financial information that is both customarily and actually treated as private by its owner. Under the Freedom of Information Act (FOIA) (5 U.S.C. 552), CBI is exempt from public disclosure. If your comments responsive to these special conditions contain commercial or financial information that is customarily treated as private, that you actually treat as private, and that is relevant or responsive to these special conditions, it is important that you clearly designate the submitted comments as CBI. Please mark each page of your submission containing CBI as “PROPIN.” The FAA will treat such marked submissions as confidential under the FOIA, and the indicated comments will not be placed in the public docket of these special conditions.

Submissions containing CBI should be sent to Steve Slotte, Aircraft Systems, AIR-623, Technical Innovation Policy Branch, Policy and Innovation Division, Aircraft Certification Service, Federal Aviation Administration, 2200 South 216th Street, Des

Moines, Washington 98198; telephone and fax 206-231-3160; Steve.Slotte@faa.gov.

Comments the FAA receives, which are not specifically designated as CBI, will be placed in the public docket for these special conditions.

Docket: Background documents or comments received may be read at <https://www.regulations.gov/> at any time. Follow the online instructions for accessing the docket or go to Docket Operations in Room W12-140 of the West Building Ground Floor at 1200 New Jersey Avenue, SE, Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.

FOR FURTHER INFORMATION CONTACT: Stephen Slotte, Aircraft Systems, AIR-623, Technical Innovation Policy Branch, Policy and Innovation Division, Aircraft Certification Service, Federal Aviation Administration, 2200 South 216th Street, Des Moines, Washington 98198; telephone and fax (206) 231-3163; Steve.Slotte@faa.gov.

SUPPLEMENTARY INFORMATION: The substance of these special conditions has been published in the *Federal Register* for public comment in several prior instances with no substantive comments received. Therefore, the FAA has determined that prior public notice and comment are unnecessary, and finds that, for the same reason, good cause exists for adopting these special conditions upon publication in the *Federal Register*.

Comments Invited

The FAA invites interested people to take part in this rulemaking by sending written comments, data, or views. The most helpful comments reference a specific portion of the special conditions, explain the reason for any recommended change, and include supporting data.

The FAA will consider all comments received by the closing date for comments. The FAA may change these special conditions based on the comments received.

Background

On September 30, 2018, Boeing applied for an amendment to Type Certificate No. T00001SE to include the new Model 777-9 series airplane. The Boeing Model 777-9 airplane, which is a derivative of the Boeing Model 777 airplane currently approved under Type Certificate No. T00001SE, is a twin-engine, transport-category airplane with seating for 495 passengers, and a maximum takeoff weight of 775,000 lbs.

Type Certification Basis

Under the provisions of title 14, Code of Federal Regulations (14 CFR), § 21.101, Boeing must show that the Model 777-9 series airplane meets the applicable provisions of the regulations listed in Type Certificate No. T00001SE, or the applicable regulations in effect on the date of application for the change, except for earlier amendments as agreed upon by the FAA.

If the Administrator finds that the applicable airworthiness regulations (e.g., 14 CFR part 25) do not contain adequate or appropriate safety standards for the Boeing Model 777-9 series airplane because of a novel or unusual design feature, special conditions are prescribed under the provisions of § 21.16.

Special conditions are initially applicable to the model for which they are issued. Should the type certificate for that model be amended later to include any other model that incorporates the same novel or unusual design feature, or should any other model already included on the same type certificate be modified to incorporate the same novel or unusual design feature, these special conditions would also apply to the other model under § 21.101.

In addition to the applicable airworthiness regulations and special conditions, the Boeing Model 777-9 series airplane must comply with the fuel vent and exhaust emission requirements of 14 CFR part 34 and the noise certification requirements of 14 CFR part 36.

The FAA issues special conditions, as defined in 14 CFR 11.19, in accordance with § 11.38, and they become part of the type certification basis under § 21.101.

Novel or Unusual Design Features

The Boeing Model 777-9 series airplane will incorporate the following novel or unusual design feature:

Electrical and electronic systems that perform critical functions, the loss of which may result in loss of flight controls and other critical systems and may be catastrophic to the airplane.

Discussion

The Boeing Model 777-9 series airplane has a fly-by-wire flight control system that requires a continuous source of electrical power in order to maintain an operable flight control system. Section 25.1351(d), Operation without normal electrical power, requires safe operation in visual flight rule (VFR) conditions for at least five minutes after loss of normal electrical power excluding the battery. This rule is structured around a traditional design using mechanical control cables and linkages for flight control. These manual controls allow the crew to maintain aerodynamic control of the airplane for an indefinite period of time after loss of all electrical power. Under these conditions, a mechanical flight control system provides the crew with the ability to fly the airplane while attempting to identify the cause of the electrical failure, restart engine(s) if necessary, and attempt to re-establish some of the electrical power generation capability.

A critical assumption in § 25.1351(d) is that the airplane is in VFR conditions at the time of the failure. This is not a valid assumption in today's airline operating environment where airplanes fly much of the time in instrument meteorological conditions (IMC) on air traffic control defined flight paths. Another assumption in the existing rule is that the loss of all normal electrical power is the result of the loss of all engines. The five-minute period in the rule is to allow at least one engine to be restarted

following an all-engine power loss in order to continue the flight to a safe landing. However, service experience on airplane models with similar electrical power system architecture as the Boeing Model 777-9 airplane has shown that at least the temporary loss of all electrical power for causes other than all-engine failure is not extremely improbable.

To maintain the same level of safety envisioned by the existing rule with traditional mechanical flight controls, the Boeing Model 777-9 series airplane design must not be time-limited in its operation under all reasonably foreseeable conditions, including loss of all normal sources of engine or auxiliary power unit (APU)-generated electrical power. Unless Boeing can show that the non-restorable loss of the engine and APU power sources is extremely improbable, Boeing must demonstrate that the airplanes can maintain safe flight and landing (including steering and braking on the ground for airplanes using steer/brake-by-wire and/or fly-by-wire speed brake panels) with the use of its emergency/alternate electrical power systems. These electrical power systems, or the minimum restorable electrical power sources, must be able to power loads that are essential for continued safe flight and landing, including those required for the maximum length of approved flight diversion.

These special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

Applicability

As discussed above, these special conditions are applicable to the Boeing Model 777-9 series airplane. Should Boeing apply at a later date for a change to the type certificate to include another model incorporating the same novel or unusual design feature, these special conditions would apply to that model as well.

Conclusion

This action affects only a certain novel or unusual design feature on one model series of airplanes. It is not a rule of general applicability.

List of Subjects in 14 CFR Part 25

Aircraft, Aviation safety, Reporting and recordkeeping requirements.

Authority Citation

The authority citation for these special conditions is as follows:

Authority: 49 U.S.C. 106(f), 106(g), 40113, 44701, 44702, 44704.

The Special Conditions

Accordingly, pursuant to the authority delegated to me by the Administrator, the following special conditions are issued as part of the type certification basis for the Boeing Commercial Airplanes Model 777-9 series airplanes.

In lieu of 14 CFR 25.1351(d), the following special conditions apply:

- (a) The applicant must show by test or a combination of test and analysis that the airplane is capable of continued safe flight and landing with all normal electrical power sources inoperative, as prescribed by paragraphs (a)(1) and (a)(2), below. For purposes of these special conditions, normal sources of electrical power generation do not include any alternate power sources such as the battery, ram air turbine, or independent power systems such as the flight control permanent magnet generating system. In showing capability for continued safe flight and landing, the applicant must account for systems capability, effects on crew workload and operating conditions, and the physiological needs of the flightcrew and passengers for the longest diversion time for which the applicant is seeking approval.
 - (1) In showing compliance with this requirement, the applicant must account for common-cause failures, cascading failures, and zonal physical threats.

- (2) The applicant may consider the ability to restore operation of portions of the electrical power generation and distribution system if it can be shown that unrecoverable loss of those portions of the system is extremely improbable.

The design must provide an alternative source of electrical power for the time required to restore the minimum electrical power generation capability required for safe flight and landing. The applicant may exclude unrecoverable loss of all engines when showing compliance with this requirement.

- (b) Regardless of any electrical generation and distribution system recovery capability shown under paragraph (a) of these special conditions, sufficient electrical system capability must be provided to:

- (1) Allow time to descend, with all engines inoperative, at the speed that provides the best glide distance, from the maximum operating altitude to the top of the engine restart envelope, and

- (2) Subsequently allow multiple start attempts of the engines and auxiliary power unit (APU). The design must provide this capability in addition to the electrical capability required by existing part 25 requirements related to operation with all engines inoperative.

- (c) The airplane emergency electrical power system must be designed to supply:

- (1) Electrical power required for immediate safety, which must continue to operate without the need for crew action following the loss of the normal electrical power, for a duration sufficient to allow reconfiguration to provide a non-time-limited source of electrical power.

- (2) Electrical power required for continued safe flight and landing for the maximum diversion time.

- (d) If the applicant uses APU-generated electrical power to satisfy the requirements of these special conditions, and if reaching a suitable runway for landing is

beyond the capacity of the battery systems, then the APU must be able to be started under any foreseeable flight condition prior to the depletion of the battery or the restoration of normal electrical power, whichever occurs first. Flight test must demonstrate this capability at the most critical condition.

- (1) The applicant must show that the APU will provide adequate electrical power for continued safe flight and landing.
 - (2) The operating limitations section of the airplane flight manual (AFM) must incorporate non-normal procedures that direct the pilot to take appropriate actions to activate the APU after loss of normal engine-driven generated electrical power.
- (e) As part of showing compliance with these special conditions, the tests to demonstrate loss of all normal electrical power must also take into account the following:
- (1) The assumption that the failure condition occurs during night instrument meteorological conditions (IMC) at the most critical phase of the flight, relative to the worst possible electrical power distribution and equipment-loads-demand condition.
 - (2) After the un-restorable loss of normal engine generator power, the airplane engine restart capability is provided and operations continued in IMC.
 - (3) The airplane is demonstrated to be capable of continued safe flight and landing. The length of time must be computed based on the maximum diversion time capability for which the airplane is being certified. The applicant must account for airspeed reductions resulting from the associated failure or failures.
 - (4) The airplane must provide adequate indication of loss of normal electrical power to direct the pilot to the non-normal procedures, and the operating

limitations section of the AFM must incorporate non-normal procedures that will direct the pilot to take appropriate actions.

Issued in Kansas City, Missouri, on September 29, 2021.

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[FR Doc. 2021-21540 Filed: 10/1/2021 8:45 am; Publication Date: 10/4/2021]